

THE MISSISSIPPI RIVER BLUFFS AT COLUMBUS AND HICKMAN, KENTUCKY, AND THEIR FOSSIL FLORA.

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The so-called bluffs which constitute a sharp boundary between the present alluvial plain or bottom of the Mississippi River and the uplands of western Kentucky, Tennessee, and Mississippi usually lie somewhat distant from the present river channel. The mighty father of the waters impinges on this escarpment at the present time both toward the mouth of the Ohio and in southwestern Tennessee. The resulting river bluffs are famed in history and tradition; they have been landmarks for the Indians, the raftsmen, and the packet-boat pilots, and they are not without interest for the physiographer and geologist.

It is the purpose of the present brief contribution to show that the basal beds of the Mississippi Bluffs of western Kentucky at Hickman in Fulton County and in the vicinity of Columbus in Hickman County (the latter known as the Chalk Banks) are of Pleistocene age and not early Eocene as has been supposed by the majority of geologists who have studied the region, and consequently are remnants of a post-Tertiary alluvial plain of the Mississippi River at a considerably higher level than the present Mississippi plain. Also to show that the overlying "bluff gravels" commonly referred to the Lafayette formation are consequently Pleistocene and not Pliocene in age and that they are of fluvial origin.

Without an exhaustive study of the early literature which would be without profit in the present connection it is difficult to say who first studied the Hickman and Columbus Bluffs. Sir Charles Lyell visited the region and makes some interesting suggestions regarding an earlier Mississippi plain about 200 feet above the present one, both in the account of his second visit (vol. 2, chap. 34) and in the fifth edition of his *Manual* (pp. 121-122). David Dale Owen and Leo Lesquereux visited the Chalk Banks, 2 miles south of Columbus, just after the middle of the nineteenth century and were fortunate in discovering and collecting impressions of leaves in the basal portion of the sandy

clays. The section is discussed by Owen in the first volume of the Geological Survey of Kentucky (p. 22) and the plants were briefly described by Lesquereux in the American Journal of Science for 1859 (ser. 2, vol. 27, pp. 364-365).

The following species were enumerated:

<i>Quercus virens</i> (Michaux).	<i>Cænothus americanus?</i> (Linnæus)
<i>Castanea nana?</i> (Muhlenburg).	<i>Carya oliveæformis</i> (Nuttall).
<i>Ulmus alata?</i> (Michaux).	<i>Acorus calamus</i> (Linnæus).
<i>Ulmus</i> sp.	<i>Gleditschia triacanthos</i> (Linnæus).
<i>Planera gmelini</i> (Michaux).	Catkins of Alnus or Betula.
<i>Prinos integrifolia</i> (Elliott).	

These are all still existing species and indicated according to Lesquereux that the beds were of Pleistocene age. (See his remarks on this point on pp. 360 and 366).

Many years subsequent to the visit of Owen and Lesquereux, R. H. Loughridge made an exhaustive study of western Kentucky and presented his results in his Report on the Geological and Economic features of the Jackson Purchase Region.¹ Good accounts of both the Hickman and Columbus Bluffs are given, the former in a graphic section on page 38 and the latter on pages 46 and 218. Loughridge mentioned no vegetable remains at the Hickman Bluff except subfossil cypress knees in the recent river sediments and regarded the deposits as constituting the oldest known Eocene of the embayment area, giving to them the provisional name of the Hickman group. He mentioned leaves from the Columbus Bluffs, but apparently made no collections and assigned the deposit containing them to the "Lignitic" (roughly corresponding to the Wilcox as now understood).

During the years 1903-1906 L. C. Glenn made a study of this area, his results forming Water Supply Paper No. 164 of the United States Geological Survey. He collected a few fossil plants from the exposure just north of Columbus and discovered and collected fossil plants from the Hickman bluff. These two collections were examined by F. H. Knowlton, who stated² that the Columbus collection contained two species of *Quercus* and a species of *Salix*; the Hickman collection "a *Salix*, *Menispermum canadense* L., and *Tecoma radicans* L., or something near it." Both deposits were regarded as of Pliocene age. Glenn, while he recognized the possibility of these leaf-bearing beds being younger than the Wilcox, placed them in the upper part of that division of the Eocene, concluding that he did not have "sufficient stratigraphic evidence for such a separation." The present writer did not have an opportunity of visiting these outcrops until the summer of 1913. While there is considerable variation in the height of the bluffs and in the lithologic character of the beds, the following some

¹ Geol. Surv. Ky., 1888.

² Water Supply Paper No. 164, p. 38.

what generalized sections will aid the reader in understanding the relations.¹

About one-eighth of a mile above Columbus the bluff is nearly 200 feet high and shows the following sequence of materials

	Feet.
1. Loess apparently grading into the underlying member	50-60
2. Yellowish to brownish ferruginous sand, often indurated, grading downward into a heavy gravel with some cobbles, often indurated to form great masses of conglomerate, the lower one-third to one-half of the member conglomeratic the whole	40-50
3. Gray sandy alluvial-looking laminated to massive siliceous leaf-bearing clay, toward the north in places a pink slightly sandy plastic clay about	80

Southward a quarter of a mile and just north of the town the basal portion of the bluff is made up of coarse angular somewhat silty, loose, very crossbedded sand, carrying pellets and some laminae one to three inches thick of grayish clay. These sands are prevailingly gray with some ferruginous brown streaks and become finer and more argillaceous upward. The clays appear at first silty and drab but bleach to almost white and become indurated upon exposure and the leaf substance, represented by ulmic, humic or ferruginous materials, is leached out, leaving only faint impressions. In places the leaves form matted layers exactly comparable with those found in recent river deposits.

At the Chalk Banks, 2 miles south of Columbus, the section is also variable and has been much cut and slumped since the days of Owen and Lesquereux. Following is a somewhat generalized section at the latter locality:

	Feet.
1. Loess more or less covered	60-80
2. Compact ferruginous heavy gravel in a coarse sand	10-15
3. Yellowish iron-stained slacked clay grading downward into next member about	10
4. Gray clay with considerable fine white sand, generally thickly laminated and sparingly leaf bearing about	50

At Hickman the bluff is about 185 feet above low water. The following section is somewhat generalized since there is considerable lateral variation:

	Feet.
1. Loess about	65
2. Heavy gravel	10-15
3. Gray siliceous micaceous leaf-bearing clay with calcareous concretions becoming more sandy and softer toward the base about	105

This lower 105 feet is obviously a formational unit, although Glenn separates the softer basal 30 feet from the overlying 75 feet. The clays are very unevenly laminated; where they are more sandy and thinly laminated they contain more water, are darker in color, and the leaf impressions are better preserved—where they are less sandy and more massive, they are lighter in color, more indurated and the

¹ As previously mentioned, detailed sections have been given by Owen and Loughridge, but as the river is cutting rapidly the exposures change from year to year.

leaf impressions are very faint. The latter materials are almost exactly like those in the Columbus Bluffs. In several years field study of the Wilcox, from Alabama to Texas, the writer has never seen Wilcox materials at all like those in the Hickman and Columbus Bluffs, while on the other hand the materials are very similar to those of numerous Pleistocene leaf-bearing river terraces from North Carolina to Mississippi. The leaf impressions are the same in all of these sections, those found at each outcrop being recorded in the following annotated list. All but two represent still existing species with climatic requirements very similar to those still growing in this same area. A consideration of this list leads inevitably to the conclusion that these outcrops are entirely of Pleistocene age and of fluvial origin. This being true the heavy gravels commonly referred to the Lafayette formation that overlie the leaf-bearing clays are also Pleistocene and not Pliocene and are likewise fluvial in origin as they are also in character. A transgressing sea forming a blanket deposit shapes pebbles differently in beach shingle. How far eastward from the present river this earlier and Pleistocene alluvial deposit extends it is hard to state definitely, since exposures are infrequent and the problem would require extended field studies. Probably they did not extend very far, since the bluffs northward at Wickliffe, Kentucky, carry plant fossils and are unquestionably of Wilcox age and those between Memphis and Randolph, Tennessee, likewise fossiliferous, are of upper Eocene age. There are some well records at Hickman, but they are too indefinite to show the contact with the Wilcox, which, however, is demonstrated to underlie the outcropping Pleistocene.

Following is an enumeration of the forms collected:

Order CONIFERALES.

Family PINACEAE.

Genus TAXODIUM L. C. Richard.

TAXODIUM DISTICHUM (Linnaeus) L. C. Richard.

Taxodium distichum (LINNAEUS) Richard, HOLMES, Journ. Elisha Mitchell Soc. for 1884-85, 1885, p. 92.—HOLLICK, Md. Geol. Surv. Pli. and Pleistocene, 1906, pp. 218, 237, pl. 68.—BERRY, *Torreya*, vol. 6, 1906, p. 89; Journ. Geol., vol. 15, 1907, p. 339; Amer. Nat., vol. 43, 1909, pp. 432, 433, 434, figs. 1, 2; *Torreya*, vol. 10, 1910, p. 263; Amer. Journ. Sci., ser. 4, vol. 29, 1910, p. 391; Plant World, vol. 14, 1911, pp. 39-45, figs. 1, 2.

The remains of the bald cypress are very common in American Pleistocene deposits from New Jersey and Maryland southward, where they are represented by the deciduous twigs, conescales, seeds, aments, and stumps with the characteristic "knees."

A single twig was found associated with the other plant remains in the clays at Hickman, this rarity apparently indicating that the cypress was not abundant in the immediate vicinity or up the river at the time these clays were deposited.

Order JUGLANDALES.

Family JUGLANDACEAE.

Genus HICORIA Rafinesque.

HICORIA PECAN (Marsh) Britton.

Carva olivaeformis Nuttall, LESQUEREUX, Amer. Journ. Sci., ser. 2, vol. 27, 1859, p. 365.

Both leaflets and nuts were recorded by Lesquereux from the Chalk Banks near Columbus in 1859. I found no nuts, but the leaflets are very common in the bluffs both north and south of Columbus and sparingly represented at Hickman. One specimen collected showed the terminal and two pairs of lateral leaflets attached to the rachis. This occurrence would seem to lend considerable weight to the theory advanced by Mohr and others that the pecan is indigenous in the eastern Gulf region.

HICORIA GLABRA (Miller) Britton.

Carya porcina Nuttall, MERCER, Journ. Acad. Nat. Sci. Phila., ser. 2, vol. 11, 1899, pp. 277, 281, figs. 4, 5, 8, 12, 16.

Hicoria glabra (Miller) Britton, BERRY, Torrey, vol. 6, 1906, p. 89; Journ. Geol., vol. 15, 1907, p. 340; Torrey, vol. 9, 1909, p. 97, figs. 1-5; vol. 10, 1910, p. 264, fig. 1.

The pignut hickory has been recorded from a number of Pleistocene localities in New Jersey, Pennsylvania, Maryland, Virginia, and North Carolina, being represented by nuts, husks, and leaves. A characteristic large terminal leaflet was found at Hickman and a less certainly identified lateral leaflet was collected at Columbus.

This species is, with the exception of the pecan, our most southerly ranging hickory, reaching its present maximum development in the lower Ohio River basin, and it is certainly significant in its bearing on local Pleistocene climates that these two species should be found fossil in western Kentucky.

Order SALICALES.

Family SALICACEAE.

Genus SALIX Linnaeus.

SALIX VIMINALIFOLIA, new species.

Leaves linear-lanceolate in outline, of relatively large size, about 15 cm. in length by 2.25 cm. in maximum width, gradually narrowed to the acuminate tip and somewhat abruptly narrowed to the broadly cuneate base. Margins entire in all of the specimens collected. Venation typical of *Salix*.

The present species is named from its resemblance to the leaves of the existing *Salix viminalis* Linnaeus, from which, however, it is perfectly distinct, as it seems to be also from existing American species of *Salix*. It is represented by three specimens from Hickman and is present in considerable abundance in the late Pleistocene of North Carolina.

Type.—Cat. No. 34963, U.S.N.M.

Genus POPULUS Linnaeus.

POPULUS, species.

Characteristic staminate aments of a species of *Populus* are not uncommon in the clays at Hickman. They are 3 or 4 inches long and probably represent either *Populus heterophylla* Linnaeus or *Populus deltoides* Marsh, presumably the latter species, since they are hardly stout enough to be referred to the former. They are not well enough preserved to show the details of their organization, but they do show clearly the bracts and the subtended masses of stamens.

Order FAGALES.

Family BETULACEAE.

Genus BETULA Linnaeus.

BETULA NIGRA Linnaeus.

Betula nigra Linnaeus, KNOWLTON, Amer. Geol., vol. 18, 1896, p. 371.—BERRY, Journ. Geol., vol. 15, 1907, p. 341; Amer. Nat., vol. 41, 1907, p. 692, pl. 2, figs. 2-4; vol. 43, 1909, p. 435; Amer. Journ. Sci., ser. 4, vol. 29, 1910, p. 393.

The river birch is not uncommon in our fluvial Pleistocene deposits, having been already recorded from West Virginia, Virginia, North Carolina, Georgia, and Alabama. It is represented by leaves in the Hickman Bluff. In the existing flora it is a distinctly mesophytic type of stream and lake borders with a wide range extending from Massachusetts to Iowa and southward to Florida and Texas.

BETULA, species.

The lignified remains of catkins are very common both at Columbus and Hickman. Similar remains were collected by Owen and Lesquereux from the Chalk Banks below Columbus and were referred to by the latter author as "catkins of *Alnus* or *Betula*"¹. After careful comparisons I have concluded that they represent the mature pistillate catkins of *Betula*, which, although the scales are normally deciduous, often remain intact, especially if not thoroughly mature and dry, and are readily preserved in river muds.

¹ Lesquereux, Amer. Journ. Sci., ser. 2, vol. 27, 1859, p. 365.

Family FAGACEAE.

Genus FAGUS Linnaeus.

FAGUS AMERICANA Sweet.¹

Fagus ferruginea Aiton, KNOWLTON, Amer. Geol., vol. 18, 1896, p. 371.—MERCER, Journ. Acad. Nat. Sci. Phila., ser. 2, vol. 11, 1899, pp. 277, 281, fig. 8¹⁵.

Fagus americana Sweet, HOLLICK, Md. Geol. Surv., Pl. and Pleist., 1906, p. 226.—BERRY, Torreyia, vol. 6, 1906, p. 88; Journ. Geol., vol. 15, 1907, p. 341; Amer. Nat., vol. 41, 1907, p. 692, pl. 2, fig. 7; vol. 43, 1909, p. 435; Amer. Journ. Sci., ser. 4, vol. 29, 1910, p. 393.

The beech is widely distributed in the fluvial Pleistocene deposits of the Southern States, where it is commonly represented by nuts and husks as well as leaves. Leaves are sparingly represented at the Columbus Bluff. In the existing flora the beech is a common river-bottom type ranging from southern Canada to Florida and Texas.

Genus QUERCUS Linnaeus.

QUERCUS, species.

Two lignitized acorns were collected from the clays of the Columbus Bluff. Although exact determination has not been attempted, they obviously represent a recent species and strongly suggest those of *Quercus alba* Linnaeus.

Order URTICALES.

Family ULMACEAE.

Genus ULMUS Linnaeus.

ULMUS ALATA Michaux.

Plate 12, fig. 6.

Ulmus alata Michaux, LESQUEREUX, Amer. Journ. Sci., ser. 2, vol. 27, 1859, p. 565.—BERRY, Journ. Geol., vol. 15, 1907, p. 343; Amer. Nat., vol. 41, 1907, p. 694, pl. 1, figs. 6, 7; Amer. Journ. Sci., ser. 4, vol. 29, 1910, p. 396.

This species was recorded by Lesquereux from the Chalk Banks near Columbus in 1859. It has since been recorded from the late Pleistocene of North Carolina and Alabama. Characteristic leaves of this species are common in the clays at Hickman. The specimen figured, however, is not typical and is of questionable identity.

In the existing flora this species ranges from southern Virginia to southern Illinois and southward to Florida and Texas, hence the fossil occurrence at Hickman is near the northern limit of its present range.

¹ The latest name of the systematists for this species is *Fagus grandifolia* Ehrhart.

Genus *PLANERA* J. F. Gmelin.*PLANERA AQUATICA* (Walter) J. F. Gmelin.

Planera gmelini Michaux, LESQUEREUX, Amer. Journ. Sci., ser. 2, vol. 27, 1859, p. 365.

Planera aquatica (Walter) Gmelin, BERRY, Journ. Geol., vol. 15, 1907, p. 343.

Leaves of water elm were recorded by Lesquereux from the Chalk Banks near Columbus in 1859 and more recently they have been found in the late Pleistocene river terraces (Chowan formation of North Carolina. They are included in the present collections from both Hickman and Columbus.

In the existing flora this species, which inhabits swamps and river bottoms, ranges from North Carolina and southern Indiana southward to Louisiana and Florida.

Order RANALES.

Family MENISPERMACEAE.

Genus *CEBATHA* Förskal.*CEBATHA CAROLINA* (Linnaeus) Britton.

Plate 12, figs. 3-5.

Menispermum carolinum LINNAEUS, Sp. Pl., 1753, p. 340.

Cebatha carolina (Linnaeus), BRITTON, Mem. Torrey Bot. Club, vol. 5, 1894, p. 162.

Menispermum canadense Linnaeus, KNOWLTON in Glenn, Water Supply Paper No. 164, 1906, p. 38.

The present species, which is a slender vine, ranges from Virginia to Illinois and Kansas and southward to Florida and Texas, inhabiting stream banks and thickets bordering woodlands. The genus to which it belongs contains about 30 species, all perennial climbers, the majority confined to the tropical regions of both hemispheres. The present species has not been heretofore found in the Pleistocene to the writer's knowledge, although various members of the family are known as far back as the middle Cretaceous.

Large and small leaves are present in considerable abundance at both Hickman and Columbus.

Order SAPINDALES.

Family ILLICACEAE.

Genus *ILEX* Linnaeus.

ILEX (?), species.

Plate 12, fig. 2.

The single small leaf figured, which is tentatively referred to the genus *Ilex*, was found at Hickman.

Order UMBELLALES.

Family CORNACEAE.

Genus NYSSA Linnaeus.

NYSSA SYLVATICA Marsh.

Leaves of this species, which apparently has not hitherto been recorded from the Pleistocene, were collected at Hickman. In the existing flora it is often confused with *Nyssa biflora* Walter, and the latter species is of frequent occurrence in the late Pleistocene (Talbot formation and its equivalents) from New Jersey southward. *Nyssa sylvatica* is a low woods and swamp type ranging from Maine and Michigan southward to Florida and Texas.

Order ERICALES.

Family ERICACEAE.

Genus XOLISMA Rafinesque.

XOLISMA LIGUSTRINA (Linnaeus) Britton.

Plate 12, fig. 1.

Xolisma ligustrina (Linnaeus) Britton, HOLLICK, Md. Geol. Surv., Pl. and Pleist., p. 236, 1906, pl. 69, fig. 6.—BERRY, Journ. Geol. vol. 15, 1907, p. 346; Amer. Nat., vol. 41, 1907, p. 696, pl. 2, fig. 6; Amer. Journ. Sci., ser. 4, vol. 29, 1910, p. 398.

This species, represented by leaves in the Hickman Bluff, has been previously recorded from the late Pleistocene of Maryland, North Carolina, and Alabama. In the existing flora it is an inhabitant of swamps and wet places ranging from New England to Florida and west to Arkansas, so that its fossil occurrence at Hickman is north of its present northern limit in the Mississippi Valley.

Order GENTIANALES.

Family OLEACEAE.

Genus FRAXINUS Linnaeus.

FRAXINUS AMERICANA Linnaeus.

This species has apparently not been found before in the fossil state. It is represented by leaves at the Hickman Bluff. In the existing flora it ranges from Nova Scotia to Minnesota and southward to Florida and Texas. Its habitat is rich, usually moist woodland near streams, and it is said to reach its maximum size in the bottom lands of the lower Ohio River.

Order POLEMONIALES.

Family BIGNONIACEAE.

Genus TECOMA Jussieu.

TECOMA PRERADICANS, new species.

Plate 13, figs. 1-5.

Leaves odd pinnate, not tendril bearing, of five or more sessile leaflets. No complete leaves have been found, but from the small size of the basal pair of leaflets in specimens showing five leaflets it seems safe to assume that the normal number was from five to seven. Leaflets lanceolate to ovate or obovate in outline, ranging from 2 cm. to 7 cm. in length and from 1 cm. to 4.5 cm. in maximum width. Terminal leaflet equilateral, the base decurring to a pseudo-petiolute. Lateral leaflets slightly inequilateral. Bases and tips about equally pointed. Margins entire for about one-third of the distance upward; above this they are beset with somewhat irregular, prominent, upwardly directed serrate teeth. Midribs relatively stout. Secondaries stout, numerous; about nine opposite to alternate pairs diverge from the midrib at angles averaging about 45° , curving slightly upward, almost regularly spaced, subparallel and craspedodrome.

The present species is similar to the existing *Tecoma radicans* in general appearance, and specimens collected by Glenn at Hickman were identified by Knowlton¹ as this species or something near it. It differs from the existing species in the fewer leaflets, the latter species having usually 9 to 13, and extended search has not brought to light leaves with fewer than seven leaflets. Other differences shown by the fossil are its smaller and more close-set marginal teeth, the tendency of the leaflets to assume an obovate outline, and the absence of the produced acumen that characterizes the leaflets of the trumpet-creeper. The secondaries are also more uniformly craspedodrome in the fossil form.

Tecoma preradicans occurs at both the Columbus and Hickman Bluffs, being exceedingly common at the latter locality. The genus *Tecoma* consists of about 80 species of the Temperate and Tropical Zones of both hemispheres. They are massed in the Brazilian region. Two species extend into the United States. One of these, *T. stans*, made the type of the genus *Stenolobium* Don by Small, ranges from Florida to Mexico and tropical America, the other, *T. radicans*, made the type of the genus *Campsis* Loureiro by Small, ranges northward to southern New Jersey along the Atlantic coast and to southern Illinois in the Mississippi Valley.

¹ In Glenn, Water-Supply and Irrigation Paper, No. 164, p. 38.

The proportion of still existing species and the occurrence of one of the two fossil species, i. e., *Salix viminalifolia*, in the late Pleistocene (Chowan formation) of North Carolina would seem to indicate that the deposits of the Hickman and Columbus Bluffs are of late Pleistocene age, but since the range of both existing and fossil plants in the Pleistocene is so imperfectly known this is not demonstrated. Since a majority of the forms recorded are prevailing southern forms, and several, as *Ulmus alata*, *Planera aquatica*, *Cebatha carolina*, *Xolisma ligustrina*, find their present northern limit near the latitude of Columbus, it follows that the climate was not very different as regards rainfall and temperature from that of the present in western Kentucky. This is also indicated by the fact that several of these species attain their maximum development at the present time in the lower valley of the Ohio. It is obvious that this flora is preglacial, interglacial, or postglacial in age, which is as definitely as it can be correlated until more extensive data are available for comparison.

Although I regard it as younger, there is a possibility that the flora of the Hickman and Columbus Bluffs may be contemporaneous with an extensive flora, as yet undescribed, from southern Alabama and Mississippi, that I have considered to be of late Pliocene or early Pleistocene, probably the former, age. In the absence of Pliocene floras for comparison the question is rendered very complex.

The question of exact age of late Tertiary and Quaternary floras is still further complicated by the uncertainty as to when the Pliocene ended and the Pleistocene began. Like the comparable question of the boundary between the Pleistocene and the Recent, it is dependent almost entirely upon latitude. Until the whole subject can be considered in a philosophical and comprehensive way and in the light of a far greater array of facts than are at present available, any extended discussion is futile. Certainly as the term is ordinarily understood the flora of the Hickman and Columbus Bluffs is Pleistocene.

Types.—Cat. Nos. 34964–34968, U.S.N.M.

EXPLANATION OF PLATES.

PLATE 12.

Fig. 1. *Xolisma ligustrina* (Linnaeus) Britton.

2. *Ilex*, species.

3–5. *Cebatha carolina* (Linnaeus) Britton.

6. *Ulmus alata* Michaux.

All from the early Pleistocene of Hickman, Ky.

PLATE 13

Figs. 1–5. *Tecoma preradicans*, new species.

Early Pleistocene of Hickman, Ky.